groupings of two and of three carbon atoms; the last are produced only when the vapours of complex carbon compounds are induced to form "positive rays."

The question of multiple charges carried by an atom is discussed at considerable length; it would appear that a mercury atom may carry as many as 8 charges; an atom of krypton, 4 or 5; one of argon, 3; one of neon, 2; of nitrogen and of oxygen, 2; and of helium, also 2; no hydrogen atom with more than one charge has been observed. The larger the number of charges carried, the fainter the line. But the intensity of the parabolic line, whether seen on a Willemite screen or photographed, is by no means proportional to the amount of element producing it. The hydrogen parabola, for instance, is always much more intense than would be accounted for by the relative amount of hydrogen present. To prove this, a most ingenious device was adopted; a parabolic slit in the screen was interposed between the source of the rays and a metallic box, connected with an electrometer; by altering the intensity of the magnetic field, the parabolas were made to fall on the slit, and the rays passed through into the box, and registered their intensity on the electrometer. In this way the relative quantity of the gaseous elements present was estimated with fair accuracy.

Proof was also obtained that helium is a monatomic gas, while oxygen and hydrogen are diatomic; for in the discharge-tube, besides detachment of a corpuscle from a molecule, the splitting up of a molecule into its constituent atoms takes place.

Chapters follow on retrograde and on anode rays; and Stark's interesting observations on the Doppler effect are described and amplified; also a short account of the spectra produced by bombardment with positive rays.

Next follows a chapter on the use of positive rays for chemical analysis; the preface states that "one of the main reasons for writing this book was the hope that it might induce others, and especially chemists, to try this method of analysis." I fear that it will not have this result. It is a pity that Sir Joseph Thomson in this chapter had not given a more detailed account of his methods, with more elaborate diagrams of the apparatus. Even to one skilled in work of this nature, what appear no doubt commonplaces to him require elucidation. For example, how many amperes are necessary to incite his magnets? What is the size of the magnets? What electric field is required? What voltage must be applied to the plates giving an electrostatic field? One would require to visit the Cavendish laboratory, or to trouble its director with correspondence before one could set up an apparatus in working order.

A discussion then follows of Mr. Aston's interesting investigation of neon, with the object of ascertaining whether neon, which has the atomic weight 20·2, contains a gas of atomic weight 22; the existence of the latter is indicated by positive rays in neon. To my mind it is scarcely credible that a mixture of gases, separable by diffusion, as Mr. Aston finds, cannot be separated by distillation and yet neither Mr. Watson, who determined the atomic weight of neon, nor Mr. Aston, who repeated Mr. Watson's experiments, have been able to effect any separation by fractionation. Further work, however, will no doubt settle the question. The existence of "X_3" is next treated of; and the reasons for believing it to be a hydrogen "ozone" appear to be cogent.

Finally, Sir Joseph Thomson deals with the continuous production of helium when certain substances are bombarded with kathode rays. Again, he does not inform us what gas was present. He is rightly very cautious in drawing any definite conclusions from his experiments; but at present his bias is in favour of the possibility of disintegration; that the matter bombarded disintegrates into helium, and some other "elementary" form of matter. He says:—"The view that helium can be got from other chemical elements raises questions of such a fundamental character that few will be prepared to accept it until every other explanation has been found to be untenable." The production of helium from radium, from niton, from thorium, and from actinium is now accepted as an undoubted fact; questions of "a fundamental character" have been raised and answered; and it appears to me to need a very small stretch of imagination to suppose that while some "elements" spontaneously undergo exothermic changes with evolution of helium, others require external sources of energy before disruption takes place.

W. R.

GEOLOGY AND MINERALOGY.

(1) *The Earth: Its Genesis and Evolution considered in the Light of the most recent Scientific Research.* By A. T. Swaine. Pp. xix + 277 + xi plates. (London: C. Griffin and Co., Ltd., 1913.) Price 7*s.* 6*d.* net.

(2) *Grundzüge der geologischen Formations- und Gebirgskunde.* By Prof. A. Tornquist. Pp. iv + 296. (Berlin: Gebrüder Borntraeger, 1913.) Price 6.80 marks.

(3) *Determinative Mineralogy.* With Tables for the Determination of Minerals by means of their Chemical and Physical Characters. By Prof.

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J. Volney Lewis. Pp. v+151. (New York: John Wiley and Sons; London: Chapman and Hall., Ltd., 1913.) Price 6*s*. 6*d*. net.

(1) MR. SWAINE'S book represents extensive reading in geological reports and journals, some of which are not easy to procure. The references to authors require some correction —T. C. Chamberlin, for instance, is consistently quoted as "Chamberlain"—but they are well chosen and are thoroughly suggestive to the student. Thanks to this free acceptance of the results obtained by field observers in many lands, a great deal of stratigraphical information is to be found within these pages. The author, however, is possessed by an idea, which forms the undercurrent of the book, and must appear somewhat startling to petrologists, if not also to biologists. He holds that the "globes of condensed vapour" (p. 9) that occur in nebulæ pass into a liquid state, producing, if we read aright, globes of water in which certain elements are dissolved.

Through the development of protoplasm in this water, and the withdrawal of the elements from solution by organisms seeking to form hard parts, a rain of mineral matter descends, and a stony nucleus is built up from the centre outwards. Calcium carbonate cannot exist in great oceanic depths, and consequently the first deposits were siliceous, and were followed by calcareous matter, similarly arising from the tests of organisms. The red clays of deep seas represent material intermediate between these types; but the chemical actions required to produce them from shells are admittedly obscure. Wherever deep oceanic basins existed during geological times, the same order of deposition has been followed (pp. 19—21); the quartzites and sandstones in such cases, which in reality mark the first sediments in a sinking area, are regarded as formed from radiolaria in a great persistent hollow which has gradually become infilled. The calcareous oozes thus represent the latest and shallowest stage.

The application of this theory to the Upper Cretaceous series of Europe (p. 22) leads to a very confused argument. Terrigenous deposits are recognised at the base, and yet these are used to support the statement that "the $CaCO_3$ decreases with the depth." Petrological examination would have kept the author from many unjustified suggestions, such as that in regard to laterite (p. 198), which is treated, in spite of an abundant literature, as an oceanic ooze. The book is obviously not a safe one for beginners, though its illustrations and mode of production go far to commend it to the reader.

(2) Prof. Tornquist's introduction to geology is of a very different order. He also reaches a description of oceanic sediments on his tenth page, and interestingly refers to Philippi's suggestion that in past times, when no polar ice-caps existed to produce unfavourable coldness, calcareous organic deposits could be formed over the deep-sea areas in general. As is fitting in a work emanating from Königsberg, the rocks of the "Eozoicum" find their type in the admirable exposures of Fennoscandia; but the absence of many formations from eastern Prussia enables the author to be wisely eclectic. Due prominence is thus given to the Silurian strata of Wales and of Bohemia; the Permian and Triassic systems receive far more adequate treatment than is usual in English text-books; and we have a good account of the Jurassic rocks of central Germany. On the other hand, we may feel that four lines (p. 222) form an insufficient reference to the Cretaceous beds of northern France and England. The earth-movements in the Harz area in Cretaceous times are illustrated on p. 227, and are shown to be forerunners of the "Saxon folding" that accompanied the formation of the Alps. On p. 263, the essentially modern nature of Europe is well expressed. The illustrations are excellent, and include the skeleton of *Allosaurus agilis* from the American Museum in New York. We should have liked some reference to the gnawed bones of the prey in this most terrible of zoological reconstructions.

(3) Prof. Lewis's manual may be regarded as convenient by those to whom the well-known work of Brush and Penfield seems unduly large. It follows similar lines and covers a wide field, and such recently discovered minerals as benitoite and purpurite are introduced. In every case references are given to the two text-books by J. D. and E. S. Dana.

G. A. J. C.

OCEANOGRAPHIC RESEARCHES.

Scientific Papers. By J. Y. Buchanan, F.R.S. Vol. i. Pp. xii+15 papers. (Cambridge: University Press, 1913.) Price 10*s*. 6*d*. net.

THE numerous expeditions which have explored the depths of the sea since the voyage of H.M.S. *Challenger* during the years 1873–76 have added much to our detailed knowledge of the conditions occurring in various seas and oceans, and in certain cases have given some idea of the periodic and irregular physical changes which take place. But the great pioneer voyage remains the only one which has surveyed the whole world of waters, and it is remarkable how little the work of more recent years, with all its advantages of previous experience and more adequate

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